Radio Astronomy

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Since 1967 radio astronomers have used the Deep Space Network (DSN) 26- and 64-meter diameter antenna stations to investigate the Moon, planets, pulsars, and radio galaxies to study the effects of solar corona on radio signals, and to observe radio emissions from X-ray sources. Very Long Baseline Interferometry (VLBI) techniques have been used for high-resolution studies of quasars, suspected black holes, and other radio sources. The high-power transmitter capability of the Goldstone 64-meter antenna has been used for radar-ranging to the planets in support of various planetary space missions and for the study of comets and asteroids. The overseas facilities in Spain and Australia have been used, on a noninterference basis with space mission operations, by host country radio astronomers. The background for the DSN support, past performance, and current plans for continued support of these activities are discussed. Various experiments of the past year are identified and summarized.

I. Introduction

The first formal recognition and joint endorsement by JPL and NASA for use of DSN facilities to support radio astronomy experiments occurred in 1967. Two years later, as more and more requests were being received, the Radio Astronomy Experiment Selection (RAES) Panel was formed by the JPL Director to evaluate and select the most appropriate and worthy non-NASA proposals to compete for the small amount of station time available for this purpose. In 1971, a NASA Management Instruction (NMI 7100.6) was issued which set forth the policy and responsibilities for "Ground-Based Radio Science." Simultaneously, NMI 1152.44 established a NASA Ground-Based Radio Science Panel "as a standing committee of NASA to provide assistance and advice to the Associate Administrator for Space Science and Applications and the Associate Administrator for Tracking and Data Acquisition on matters pertaining to ground-based radio science." Presently, these are the Office of Space Science (OSS) and the Office of Space Tracking and Data Systems (OSTDS). This panel disbanded in 1973 when it was not extended beyond the designated two-year period.

The latter NMI specified details of a long-range program and annual plan for NASA support of ground-based radio science to be provided to the Associate Administrators of OSS and OSTDS. Annually, JPL submits a fiscal plan (Ref. 1) which serves as a mini-Support Instrumentation Requirements Document for DSN support of radio astronomy.

To minimize confusion between the terms Radio Science and Radio Astronomy as applied to DSN activities, in 1977, the DSN adopted the following definitions:

(1) Radio Science pertains to the acquisition and extraction of information from spacecraft-transmitted signals which have been affected by celestial bodies or have interacted with the propagation media.

(2) Radio Astronomy pertains to the acquisition and extraction of information from signals emitted or reflected by natural sources (i.e., all sources other than spacecraft).

II. Radio Astronomy Operations

During the past year the 26- and 64-meter antenna stations have provided a total of 1972 hours of operation in support of experiments in four different categories: NASA/OSS, NASA/OSTDS, RAES, and host country-sponsored radio astronomy. Also, the Tidbinbilla stations, DSS 42 and DSS 43, provided the support necessary for the development of a Real-Time Short Baseline Interferometer sponsored by the JPL Director's Discretionary Fund.

A. NASA OSS Category

The majority of Network time, 1033 hours, has been given to this category of activity in the past year, with 784 hours being used at DSS 62 in support of the Jupiter Short-Term Variation Experiment. This is a joint investigation involving Sam Gulkis and Mike Klein at JPL, Jose Antonio Turegano at the University of Zaragoza and Eric Gerard of the Nancay Observatory in France. At this time, the data obtained are being processed.

Of the remaining time, Pulsar Rotation Constancy experiments utilized 243 hours. New timing and recording software, developed by Miguel Urech at DSS 62, is presently being tested at Goldstone and should make better and more efficient use of Network facilities when it becomes operational.

Little demand has been made by Martin Slade, the principal investigator of the ALSEP/Quasar VLBI experiment in deference to heavy Flight Project activity, but it is anticipated that work in this area will increase considerably in the near future.

Activity in support of the Southern Hemisphere Radio Source Position investigation is expected to increase in the near future meanwhile the Moon Mapping and Lunation Curve experiment is drawing to a close and publications have been made (Refs. 2, 3 and 4).

B. NASA OSTDS Category

Some 478 hours of Deep Space Network tracking time has been used in this category in support of Planetary Radar Astronomy. The majority of the time, 441 hours, was utilized to map the planet Venus while 37 hours was given over to Saturn rings mapping.

C. Radio Astronomy Experiment Selection (RAES) Category

At this time there are some ten experiments on the RAES panel-approved activities list. All of these experiments request the use of 64-meter antenna time plus the Hydrogen Maser Frequency and Timing Subsystem (Ref. 1). There is one exception to this in that RA137 (Quasar Patrol) will accept 26-meter antenna time when 64-meter antenna time is not available.

Due to the dearth of available 64-meter antenna time, the RAES panel has prioritized these experiments as follows:

RAES Panel Number	Subject	Panel Priority
RA 137	Quasar Patrol	4
RA 164	Compact Radio Source Observation	7
RA 165	Compact Nonthermal Sources	4
RA 168	Galactic Center VLBI	3
RA 169	Compact Nuclei VLBI	1
RA 170	Radio Emisson VLBI	8
RA 171	M87 Interstellar Scintillation VLBI	1
RA 172	Recombination Lines, Nearby Galaxies	10
RA 173	Hotspots in Extra-Galactic Sources	8
RA 174	M82 Compact Source VLBI	4

Only three experiments, RA 137, RA 171 and RA 164, have been supported during the past 12 to 18 months due to the extremely high spacecraft tracking requirements; however, the outlook for next year is brighter.

D. Host Country Category

(1) Australia

The Pulsar observations in Australia have been the prime host country activity receiving support to the tune of about 400 hours in the last year.

(2) Spain

Spanish host country activity has been severely limited in the past year or so, but it is hoped that this situation will improve in the post-Pioneer Saturn Encounter period.

References

1. Fahnestock, R. J., "Ground-Based Radio Astronomy Activities Using DSN Facilities – FY79 Plan," Jet Propulsion Laboratory, California Institute of Technology, Pasadena, California, November 30, 1978 (Internal Document).

2. Gary, B., and Keihm, S., "Interpretation of Ground-Based Microwave Measurements of the Moon Using a Detailed Regolith-Properties Model," *9th Proc. Lunar Planet. Science Conference*, 1978, p. 2885.

3. Keihm, S., and Gary, B., "Comparison of Theoretical and Observed 3.55-cm Wavelength Brightness Temperature Maps of the Full Moon," *10th Proc. Lunar Planet. Science Conference*, 1979.

4. Keihm, S., and Gary, B., "Interpretation of High-Resolution Lunar Brightness Temperature Maps at 3.55 cm," American Geophysical Union Meeting, Washington, D.C., 28 May 1979.